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The Effect of Technology Education on Student's State Standardized Test scores

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THE EFFECT OF TECHNOLOGY EDUCATION ON STUDENT'S STATE STANDARDIZED TEST SCORES

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Abstract

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The intent of this dissertation was to determine if technology education program completers score higher on academic standards assessments than do students who do not enroll in technology education courses. Many states have developed academic standards for public school students to measure the quality of the educational system. States and local school systems adopted these standards and their accompanying tests to establish a level of academic competency for all of their students. One of the goals of technology education courses was to provide practical applications to reinforce the content of the core subject areas. The purpose of this study was to determine if there is a significant relationship between the performance scores of technology education program completers on their state standardized assessments as opposed to students who did not have technology education courses.

Pre-existing data were retrieved from one urban high school database in southeastern Virginia. The data that were collected included the standardized assessment scores in the subjects of English/language arts, mathematics, science, and social studies. The population of technology education completers in this study was compared to a random sampling of an equal number of students that had not taken any technology education courses. Multiple *t*-tests were used to determine if there was a significant

difference in the standardized assessment scores between technology education program completers and non-program completers.

The results of this study indicated a significant difference in the scores of technology education program completers on their state standardized assessments in three of the four subject areas that were examined. The mean scores of the technology education program completers were higher than the non-completers in all four subjects that were analyzed in this study. English/language arts was the only subject where the mean scores of the program completers were not significantly higher than the non-completers. The *t* values that were determined were significant in three out of the four subject areas at the .01 level of significance, which were history, mathematics, and science.

This dissertation is dedicated to my wonderful wife Erica and my family without whom none of my achievements or successes would have been possible.

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There is a long list of people who have contributed to the successful completion of this dissertation. I truly believe that it is nearly impossible to complete a task as monumental as achieving a doctoral degree without help and support from others. Throughout the course of completing my graduate studies there have been several individuals who have been instrumental in helping me overcome numerous obstacles along the way. Because their assistance and undying support has been an invaluable resource to me, I felt it was necessary to acknowledge them for everything that their help and understanding has meant to me over the years.

I first want to acknowledge my wife Erica for her endless love and understanding through all of the good and bad times that have come with completing this degree. Whether it was proofreading one of my writing assignments in the wee hours of the morning, fixing one of those late night snacks to keep me going, or waking me up when I had fallen asleep on my keyboard, she has always been supportive of the goals that I was trying to achieve. I am also very thankful for all of her sacrifice while I had to devote a significant amount of my time and energy to meeting the requirements of this rigorous program. Without her support I do not know that this degree would have been possible and I know that I am truly blessed to have her as a part of my life.

I would next like to acknowledge my mom and dad for being instrumental in helping me achieve this point in my education. I could not have asked for a more loving, supportive, and understanding set of parents. Finishing this dissertation and completing my degree requirements has taken a significant amount of my time and effort. They have always taken the time to listen and offer advice when I needed to talk, help me when I was struggling, and applaud me in my accomplishments. I can not say enough about how influential they have been in making me into the person I am today. I am forever thankful for their tireless sacrifice while I was completing this dissertation, as well as the multitude of my educational endeavors. I will never forget everything that they have given to me and I am eternally grateful for their love and support.

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Chapter I

Introduction

Technology education is an area of study that is designed to integrate the academic core subjects by providing students with practical hands-on applications of the content through applied activities. Although technology education courses are typically listed as electives, they serve a vital role in implementing a curriculum that blends technical concepts and academic principles. The goal of technology education programs is to provide students with a higher level of technological literacy. As students start to understand various technical concepts they acquire new skills and insights, and they begin to see the value that technology education has in relation to their educational aspirations and career goals.

Many states have developed academic standards for students and relied on high stakes testing to measure and improve the quality of public education (Dyer, Reed, & Berry, 2006). States and local school systems adopted these standards and their accompanying tests to establish a level of academic competency for all of their students. As the students finish various academic subjects they are required to take standardized assessments that are intended to measure their level of mastery of the content. Many students find that if they do not reach the required minimum score for the assessment, they will have to undergo remediation and retake the test. This process can be very stressful for students since receiving a passing score often directly relates to their graduation requirements.

Technology education provides a contextual basis for reinforcing the content of the core academic areas (Berry & Ritz, 2004). The nature of technology courses is to provide practical applications that are relative to the content. Students get a true sense of how the competencies that they are learning in class can be applied to real-world situations. A significant amount of the content that is learned in technology education courses contains many of the same principles that students are learning in their academic subjects. One way to personalize the learning environment is to provide meaningful curriculum and instruction (Owings & Kaplan, 2001). If a relationship is established that students taking technology education courses contribute to an increased level of performance on the academic standardized assessments, school officials may see added value for their technology education programs.

Statement of the Problem

The problem of this study was to determine if technology education program completers score higher on academic standards assessments than do students who do not enroll in technology education courses.

Research Goals

The hypotheses that guided this study included the following:

H_1 : Students who were technology education program completers performed better on their mathematics standards tests (SOL) than students who were not enrolled in technology education courses.

H_2 : Students who were technology education program completers performed better on their social studies standards tests (SOL) than students who were not enrolled in technology education courses.

H_3 : Students who were technology education program completers performed better on their English/language arts standards tests (SOL) than students who were not enrolled in technology education courses.

H_4 : Students who were technology education program completers performed better on their science standards tests (SOL) than students who were not enrolled in technology education courses.

Background and Significance

The issue of determining whether technology education had an effect on a student's standardized assessment scores arose because of the emphasis that states and school systems were placing on students passing these tests. The focus of educational policy had shifted from school inputs to student outcomes and from minimum competency to high proficiency standards (Lee & Wong, 2004). All school districts were being held accountable for making sure that they were able to get their students to pass these standardized assessments. The Commonwealth of Virginia adopted the Standards of Learning (SOL) for the four core academic areas: English/language arts, science, mathematics, and social studies/history (Dyer, Reed, & Berry, 2006). Students must achieve an established minimum score in each of these core area tests in order to be promoted and eligible to graduate.

Establishing a link between students who completed various technology classes and their performance on academic standardized assessments may justify the need for school systems to incorporate technology curricula as a necessary part of a student's education and develop it into a core subject. In the long progression from manual training, the subject which today the profession calls technology education has always had to contend with the question of its legitimacy as valid school knowledge (Lewis, 2005). Technology education courses were commonly listed as electives when students were registering for a new school year. Because technology education courses did not have state mandated standardized assessments, school officials tended to focus their attention more toward the required core subjects.

It was important for research to be conducted that could generate results to support the need for students to be required to have a component of technology education as a part of their graduation requirements. Dyer (2004) conducted a study, which analyzed the relationship between students who had taken one or more Illustration and Design Technology courses and their performance on standardized mathematics assessments. These students were compared to students who had not taken any of the Illustration and Design Technology courses. It was found that the Illustration and Design Technology group had a 78% passing rate, while the Non-Illustration and Design Technology group had a passing rate of 73% (Dyer, Reed, & Berry, 2006). The difference between these percentages was found to be significant. Conducting research and establishing data that produced significant results could be very helpful in supporting the argument to make technology education a requirement for all students. These types of research studies opened pathways for further analysis and a more global study to encompass a greater population.

The field of technology education had developed a set of standards to ensure that students become technologically literate. One of the main goals of the *Standards for Technological Literacy* was to provide an ambitious framework for guiding student learning (ITEA, 2000). By students taking technology education courses that reinforced the core content areas and were based on the technological literacy standards, it was conceivable that they would perform better on their standardized assessments. If evidence could be established that students who took sequential technology courses academically out performed students who had not taken those courses, it would further validate the need for a strong technology education program in which all students could become more technologically literate.

Limitations

The limitations of this study were as follows:

1. The data collected were limited to graduating high school technology education program completers and a sample of non-completers from an urban high school in southeastern Virginia.
2. The data collected were limited to the Standards of Learning (SOL) examination scores of high school seniors in the core subject areas of mathematics, science, social studies, and English/language arts.
3. The data collected were limited to students who were not members of their high school band ensemble. This limitation was cited because research has shown that band students usually outperform other school populations when tested. According to Trent (2006), high school seniors who participated in instrumental music in grades 6-12 score significantly higher in language arts and math on standardized tests than do students involved in non-music extra-curricular activities or with students not involved in any related extra-curricular activity. There was a significant correlation between the number of years that a student has band instruction and academic achievement (Kluball, 2000).

Assumptions

This study was based on the following assumptions:

1. Program completers have passed each of their technology education courses and have satisfied all of the necessary competencies.
2. All of the students included in this study were receiving a regular or advanced studies graduation diploma.
3. The school involved in this study met accreditation standards that were established by the Commonwealth of Virginia.

Procedures

In order to establish a comparison of technology education program completers to non-completers, it was necessary to obtain a list of all graduating seniors that had taken at least two sequential technology education courses. Those students were compared to a random sample of students who had not taken any sequential technology courses. The assessment scores for each student were obtained from the school guidance database. The *t*-tests were used to determine if there was a significant difference in standardized assessment scores between the technology education program completers and non-program completers. The content areas that were analyzed for significance were mathematics, science, social studies, and English.

Definitions of Terms

The following definitions were provided to assist the reader in understanding the terms related to this study:

Grade Point Average (GPA): The average of a student's grades that they have received from each class they completed while in high school.

Technology Education Program Completer: According to the Virginia Department of Education (2007), a Career and Technical Education Program Completer was a student who had met the requirements for a career and technical concentration or specialization and all requirements for high school graduation or an approved alternative education program. An example of necessary requirements to complete a technology education concentration was if a student completed communication systems and graphic communications as elective courses. Another example was if a student took electronics I and electronics II as their electives.

Standards of Learning (SOL): A set of state academic standardized assessments that were used in Virginia to evaluate student mastery of their core subjects.

Standards for Technological Literacy (STL): A grouping of age-appropriate technology standards developed by the International Technology Education Association and supported by the National Academies and the National Academy of Engineering for students from Kindergarten to 12th grade (ITEA, 2000).

Overview of Chapters

This chapter discussed the basic definition of technology education and its role in educational settings. It explained the requirements that were necessary for a student to become a technology education program completer. The specific focus of the study was expressed in the problem statement. The research goals explained the areas to be analyzed in the study. A review was given to acquaint the reader as to where the need for this study arose and why it was important to conduct research on this topic. The definition of terms list was provided to aid in the reader's understanding of the study.

The Review of Literature in Chapter II will discuss details as to the standards assessment movement, technology education, integration of academics into career and technical education, and technology education's role in contributing to academic performance. The Methods and Procedures in Chapter III will explain the means by which the data were collected for the study. The Findings in Chapter IV will explain the results of the data collected. The Summary, Conclusions, and Recommendations in Chapter V will summarize and draw conclusions for the study.

Chapter II

Review of Literature

The field of technology education is an area of study that has a diverse history, which has continued to evolve and develop in order to remain up-to-date with current societal trends and innovations. In order to fully understand the current fundamental principles associated with technology education, it is necessary to explore some of the many entities that support and foster the continued success of this dynamic field. This chapter will delve into some of the major topics that are responsible for shaping the current status of the field of technology education. The topics that will be explored are the background and philosophy of the field, the standards assessment movement, the integration of subject areas, and the ways in which technology education is contributing to student academic performance. By evaluating these various areas it will be easier to understand the current focus of technology education and the directions that the field is taking in preparation for the future.

Background and Philosophy of Technology Education

Technology education as we know it today is a dynamic field that is designed to prepare students to be literate and proficient in our technologically advanced society. Citizens of developed countries are living in a world that is rapidly becoming more global in nature, where access to information and various means of communication are almost instantaneous. In order for us to understand how populations have arrived at the current status of technological advancement it is necessary to reflect upon where the discipline of technology education began. There have been numerous events, individuals, literature, and legislation that were instrumental in shaping the history of the field of technology education. By possessing an understanding and awareness of the events that took place in the history of technology education it is easier to recognize current trends and make predictions as to how the discipline will change in the future.

In order to understand the current status of technology education in the United States, it is necessary to analyze some of the major movements and events that took place as the profession was beginning. One notable era in the history of technology education was the manual training movement. The manual training movement was the precursor to the vocational training programs in our schools today (Westerink, n.d.). Two individuals who were instrumental in the progression of the manual training movement were Calvin Woodward and John Runkle. The manual training system was a Russian system that was used to train government engineers and was established by Victor Della Voss, who first used it in 1868 (Pesesky, 2003). Woodward used this system as a base for a high school called the St. Louis Manual Training School, where he saw this system as a way to benefit the total student by giving them skills that dealt with people, places, and things (Garni, n.d.). Runkle was the president of Massachusetts Institute of Technology (MIT) when he saw an example of the manual training method and adapted it as a base for the School of Mechanic Arts of MIT.

Another era that was instrumental in forming the foundation of present day technology education was the sloyd movement. The term "sloyd" is a Scandinavian word that means craft or manual skill. One of the major figures in the history of sloyd education was Solomon. Solomon was recruited to help in construction and managing of schools that were based on sloyd principles. Solomon's work resulted in the establishment of a vocational school for boys in 1872, a vocational school for girls in

1874, and a school for sloyd (craftwork) teachers in 1875 (Thorbjornsson, 1994). Ordeway brought the principles of sloyd education to America, where he taught the basic principles to students at MIT. These principles were added to an already growing trend of object-based education in America (VanIngen, 2003). It was a strong influence on the manual arts movement, which later evolved into vocational education and industrial arts education (Peseky, 2003).

The next major period of time that was significant in establishing the foundations of technology education was the industrial arts movement. One of the most widely accepted definitions of industrial arts is one that was developed in the 1920's. Industrial arts is the study of the changes made by man in the forms of materials to increase their values, and of the problems of life related to these changes (Bonser & Mossman, 1923). One of the most significant ideals of industrial arts education has always been that it was a discipline that should be designed and made available for all students. The training of the eye and the hand are important and essential elements in all good education (Bennett, 1937). Some of the significant individuals that were notable during this movement were Dewey, Bonser, and Mossmann. Dewey's philosophy, in relation to industrial arts education, was that students should "do" to develop thinking and then think about what was done which would then stimulate learning (Misner, n.d.). His focus was upon a methodology which began with identifying difficulties or problems and ended with synthesizing and coordinating knowledge and desire, resulting in the controlling and remaking of the external world (Durant, 1953). Bonser and Mossmann were faculty members at Columbia University where they formulated the industrial arts movement in reaction to the lack of social and cultural context of manual training (Foster, 1995).

Bonser and Mossmann published *Industrial Arts for Elementary Schools*, which was to become a standard text on elementary school industrial arts for many years (Sredl, 1966). Bonser and Mossman developed a comprehensive system of industrial education, which although was never implemented on a large scale, has been the theoretical basis for industrial education in the U.S. for most of the past 70 years (Foster, 1994, 1995).

The vocational education movement is another era in the history of technology education that is very significant. Early in the 20th century vocational education was a prominent topic of discussion among American educators as schools struggled to meet the labor force needs consistent with the shift from an agrarian to an industrial economic base (Wirth, 1972). The beginning of the vocational education movement in America was often identified with the report of the Commission of Industrial and Technical Education for the Commonwealth of Massachusetts, appointed by Governor Douglas (who also owned a shoe factory), hence the term the Douglas Commission (Gomez, 2001). The basis of this Commission in 1905 was that schools should include instruction in industry, agriculture, mechanics, and domestic arts for boys and girls. It also mandated that provisions should be made for industrial courses to be offered in high schools, evening courses for those employed in trades, and classes for 14 to 18 year olds who are already employed for part of the day. Educational reform by such groups as the Douglas Commission was instrumental in shaping the foundation for modern technology education practices.

Significant Events and Legislation

In addition to exploring the various eras in the history of technology education, it is necessary to investigate significant events and legislation that have been established to help shape the current philosophies of technology education. Throughout the course of the history of technology education there have been several events and legislative actions that have proven to have a strong influence on the practices of technology educators today. These events had a lasting impact in changing the focus and direction of the technology education field as it was evolving. The following section of this chapter outlines and explains the significance of the events and legislation that helped to promote growth and change in the subject area of what we now refer to as technology education.

A noteworthy piece of legislation that was instrumental in authorizing more funding for vocational education was Title II of the Educational Amendments of 1976 (Moore, n.d.). The purpose of this act was to maintain, develop, and improve vocational education programs. Other than vocational education programs, the money could be spent on school facilities, support of sex equity positions, industrial arts (now technology education), and residential vocational centers. One of the stipulations of this educational amendment was that every vocational program had to be evaluated every five years (Moore, nd).

One of the most significant pieces of legislation that has fostered the growth of technology education is the Carl Perkins Act. Originally authorized in 1984 as the Carl D. Perkins Vocational Education Act of 1984, this legislation had several key provisions. Some of these provisions included assisting the states to expand, improve, modernize, and develop quality vocational education programs to meet the needs of the nation's existing and future workforce. Another key provision consisted of assuring that all individuals were given access to quality vocational education programs such as those that were for disadvantaged, handicapped, entering non-traditional occupations, and those with limited English proficiency (Paulter, 1999). There was also a need for cooperation between public agencies and the private sector in preparing individuals for employment. The act was re-authorized in 1990 and contained changes that included the creation of a set of core standards, authorization of funding for Tech Prep programs, and provisions for bilingual programs (Paulter, 1999).

The Act was again reauthorized in 1998 and most recently in 2006 as the Carl D. Perkins Career and Technical Education Improvement Act of 2006. The most recent revisions include support for partnerships with secondary schools, postsecondary institutions, baccalaureate degree granting institutions, and career technical centers. There was also a push to the newest version of the Perkins Act to develop research and best practices to improve the quality of Career and Technical Education. Definitions have been updated and new terms such as "Career and Technical Education", "career pathways", and "articulation agreement" have been implemented (ACTE Summary of S. 250, 2005).

There were several areas in which the Perkins Act relates to the field of technology education. One of these areas that this act directly relates to technology education was the in the area of promoting technological literacy. One of the purposes of the Perkins Act was to prepare a workforce with the academic and vocational skills needed to compete successfully in a world market (U.S. Department of Education, 2002). Another aspect of technology education that was supported by the Perkins Act was related to the ideals of STEM legislation. According to the United State Department of Education (2002), Perkins funds can be used to promote efforts for academic and vocational integration. Because of the Perkins Act, technology education programs across the country have had funding to evolve and progress.

Another significant event in the recent history of technology education was the Jackson's Mill Curriculum Theory project of 1981. The Jackson's Mill Curriculum Theory was devised through meetings of national leaders who gathered in West Virginia in 1979 to1981. The Jackson's Mill curriculum theory document provided the needed systematic refocus of the curriculum formerly known as industrial arts (Wicklein, n.d.). The contributors to Jackson Mill redefined industrial arts as comprehensive educational programs concerned with technology, its evolution, utilization, and significance; with industry, its organization, personnel, systems, techniques, resources, and products; and their societal impact (Snyder & Hales, 1981,). The state of New York began to require all 8th graders to study technology, which created a market for textbooks based on the Jackson Mills Curriculum Theory (Gomez, 2001). The essence of the Jackson Mills work was that technology education began to study the system of inputs, processes, outputs, and feedbacks and by using this model it was easy to look at all areas of technology and systems so that they might be studied through the systems of communication, construction, manufacturing, and transportation. The publication of the Jackson's Mill Industrial Arts Curriculum Theory document was considered as the starting point of the modern era of technology education (Snyder & Hales, 1981).

One of the most recent reforms in the field of technology education was the adoption of the technological literacy standards. From 1996 to 2000, *Standards for Technological Literacy: Content for the Study of Technology (STL)* was developed, reviewed, published, and disseminated (Dugger, 2005). The effort was intended to show public school education that technology education should be an essential component of all educational programs. These standards described what technological literacy content should be studied in the elementary, middle, and high school grades. The individual standards presented in *Standards for Technological Literacy* were organized into five major categories, each of which was addressed in its own chapter. These major categories, around which the standards were developed, were the nature of technology, technology and society, design, abilities for a technological world, and the designed world (Dugger, 2001). *Standards for Technological Literacy* specified what every student should know and be able to do in order to be technologically literate and offered criteria by which to judge progress toward a vision of technological literacy for all students. *Standards for Technological Literacy* have become the backbone for school systems and educational entities to design curriculum in order to deliver a current and up-to-date technology education program.

Professional Organizations and Federal Agencies

Many educational organizations and institutions have adopted the philosophy of preparing students to be technologically literate when they graduate from high school. One group that is promoting this philosophy is the American Association for the Advancement of Science (AAAS). The AAAS is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson, and professional association (AAAS, 2008). Two of the major missions of AAAS are to foster education in science and technology for everyone and to increase public engagement with science and technology. One of the major initiatives that AAAS founded and developed in 1985 was "Project 2061". This initiative was devised to help all Americans become literate in science, mathematics, and technology. Its work has earned the project a reputation as the single most visible attempt at science education reform in American history (Organization of Economic Cooperation and Development, 1996). The landmark publication called *Science for All Americans* was produced in 1989 and listed recommendations for what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school. The goals of "Project 2061" and its subsequent publication are a testament to the fact that educational organizations were promoting subject integration to increase technological literacy.

The National Science Foundation (NSF) was a governmental organization that supported the promotion of technological literacy. It had funded various grants to allow universities and public school systems to provide subject integration programs to their students. One way that the National Science Foundation was fulfilling its mission of promoting curriculum integration and fostering technological literacy was by supplying school systems and universities with grants to revamp their curriculum. In 1996 the NSF launched the Institution-wide Reform of Undergraduate Education pilot program. This program offered 17 colleges and universities $200,000 to help with changing their programs to accommodate the inclusion of multiple academic subjects. The schools were shepherding in a new era in the institution-wide reform of science, mathematics and technology-related higher education (Williams, 1998). These grants were open to all institutions that enroll undergraduate students and focused on planning new programs to improve education in science, mathematics, technology, and engineering.

The International Technology Education Association (ITEA) was an organization that was committed to supporting technology education teachers by providing them with instructional materials and keeping them abreast of trends in the field of technology education. The ITEA viewed its mission as promoting technological literacy for all by supporting the teaching of technology and promoting the professionalism of those engaged in these pursuits (ITEA, 1995). In 2000, *Standards for Technological Literacy* were published and were supported by the ITEA. These standards presented a vision of what students should know and be able to do in order to be technologically literate. The standards described what the content of technology education should be for grades K-12 (ITEA, 2000). These standards have established a framework in which all technology teachers and programs can base their instruction.

Another organization that has been instrumental in promoting the integration of various subject areas and the importance of technological literacy is the National Academies. The National Academies perform public service by bringing together committees of experts in all areas of scientific and technological endeavor to address critical national issues where they can give advice to the federal government and the public. The four branches of the National Academies consist of the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. The National Academy of Engineering and the National Research Council were in charge of overseeing a committee that was formed to deal with issues relating to technological literacy. The report that was produced by the committee was called *Technically Speaking: Why All Americans Need to Know More about Technology* (NAE & NRC, 2002). This report provides a blueprint for bringing all up to speed on the role of technology in our society, including understanding such distinctions as technology versus science and technological literacy versus technical competence (National Academies of Sciences, 2008). Technological literacy is when a student has a general understanding of technology and how it relates to the world around them. Technical competence is when an individual is capable to effectively use a specific piece of technological equipment. Reports such as *Technically Speaking* were true indicators of the initiatives being put into place to promote a technologically literate society through curriculum reform in the school systems.

The Standards Movement

Aside from governmental agencies and organizations wanting all students to be technologically literate, there has been a push in the American educational system to establish and adhere to academic standards. According to Gronlund (1993), the purpose of establishing the goals is twofold: first, to increase the achievement level of all students, and second, to provide equal opportunity education for all students. The educational community can trace the start of the modern standards movement to the publication of *A Nation At Risk* in 1983 (Marzano, 1998). The publishing of this report was the catalyst that began a wave of educational reform in the United States. Events such as national education summits, the establishment of Goals 2000, and the initiation of the No Child Left Behind legislation have all been instrumental in contributing to the American education system establishing frameworks by which the various states can base their academic standards.

In 1983 *A Nation At Risk* outlined five major recommendations that the authors felt were necessary to improve the American educational system. The first recommendation was for school systems to improve their curriculum content and graduation requirements. The second recommendation was for schools to implement measurable standards with more rigors and establish higher expectations. The third recommendation was to allocate more time to instruction, which may include longer school days and school years. The fourth recommendation was for educational institutions to improve the preparation of teachers and make the profession more rewarding and respected. The fifth recommendation was for citizens to hold educators and elected officials responsible for leadership to achieve the reforms and provide fiscal support and stability that is necessary (Phelan, n.d.)

Because *A Nation At Risk* was influential in pointing out the need for educational reform and the advent of standards based education, many governmental officials began to take steps to establish new educational guidelines. According to Shepard (1993), this widely read and controversial report caused a dramatic shift in the rhetoric of education reform, so that it came to embody the concern for the basic safety of our nation. One of the first steps that were taken to establish standards reform in the educational system after *A Nation At Risk* was the first educational summit in 1989. President George H. Bush and the state governors gathered to outline six broad goals, which were subsequently published as *The National Education Goals Report: Building a Nation of Learners* (National Education Goals Panel [NEGP], 1991). Two of the goals in this outline dealt directly with specific academic standards. Goal 3 of the NEGP (1991), stated that by the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter, including English, mathematics, science, history, and geography. Goal 4 stated that by the year 2000, U.S. students would be first in the world in science and mathematics achievement. The goals outlined by this panel were ground breaking in establishing national standards in the major academic subjects.

Aside from the goals that were outlined in 1991 by the NEGP, the National Council on Education Standards and Testing (NCEST) was established in 1993. This council was established at the urging of Secretary of Education Alexander to begin the development of bi-partisan national standards and testing for K-12 education (Phelan, n.d.). The assembly of this council was eventually unsuccessful in the development of national consensus standards. In May 1993, the Goals 2000: Educate America Act, backed by President Clinton and Secretary of Education Riley, was sent to Congress. This bill acknowledged the rights of all children to an opportunity to learn, to well-trained teachers, and to a solid curriculum (Gronlund, 1993). The 1999 National Education Summit was a meeting of governors, educators, and business leaders where the focus was on improving educator quality, helping all students reach high standards, and strengthening accountability. Because of the Goals 2000 legislation and the progress made at this summit, an agreement was reached to specify how each state would deal with the challenges of tailoring their standards (Phelan, n.d.).

One of the most recent pieces of educational legislation dealing with standards and assessment was the No Child Left Behind (NCLB) Act that was passed into law in May of 2001 and signed in to law by President George W. Bush in 2002. NCLB was the current version of the longstanding federal Elementary and Secondary Education Act (ESEA), first implemented in the 1960s (Neill, 2003). This act was designed to address increasing concerns about the quality of American education. According to the White

House and Department of Education, No Child Left Behind had four pillars. The first pillar dealt with the notion that a standard must be established for schools to be measured against, and there would be rewards and consequences for improvement and failures. The second pillar dealt with allowing schools to allocate funds as needed, rather than being dictated by others. The third was applied to teachers and states that they should use established rather than experimental teaching methods. The last pillar covered the options that parents had to be able to transfer their children out of schools that were not performing to standard (Smith, 2008).

Under No Child Left Behind, schools were to be assessed annually with the assistance of standardized tests that were to be administered to all students. The general public could see how well the school was performing by looking at the Adequate Yearly Progress (AYP) report that profiled the school's performance as compared with state standards and other state schools. Schools that did not reach their required Adequate Yearly Progress scores were offered funding to assist with teacher education, tutoring, and other special programs. According to Smith (2008), proponents of the NCLB Act argued that the legislation was improving American education in a positive and measurable way. Detractors of the Act, especially classroom teachers, have pointed out many flaws in No Child Left Behind that had yet to be addressed by the Department of Education.

Since the No Child Left Behind Act was passed into law in 2001 there have been proponents that argue the positive aspects that it was bringing to American education and there were those individuals that were quick to point out what they viewed as shortcomings with the legislation. One of the many reasons that supporters of NCLB list as a positive aspect of the Act was that it contributed to improving test scores. According to U.S. Department of Education (2006), the National Assessment of Educational Progress (NAEP) results, released in July 2005, showed improved student achievement in reading and mathematics. Another positive point about NCLB that had been debated was that it was an improvement over local educational standards. Many argued that local government had failed students, necessitating federal intervention to remedy issues like teachers teaching outside their areas of expertise and complacency in the face of continually failing schools (Mizell, 2003). Some local governments, notably New York State, have voiced support for NCLB provisions, arguing that local standards had failed to provide adequate oversight over special education, and that NCLB would allow longitudinal data to be more effectively used to monitor Adequate Yearly Progress (AYP) (New York State Education Agency, 2005). A third point that has been argued in favor of NCLB was that the Act stimulated an increase in accountability. Supporters of No Child Left Behind claimed the legislation encouraged accountability in public schools, offered parents greater educational options for their children, and helped close the achievement gap between minority and white students (Department of Education, n.d.). Achievement towards these goals would be accomplished through federally mandated standardized testing.

Just as there were those individuals that agreed with NCLB legislation, there were people that had strong reservations about its goals and purpose. As the impact of the No Child Left Behind (NCLB) legislation continued to unfold across the country, educators and child advocates faced the difficult task of explaining how NCLB hurt schools instead of helping them (Neill, 2003). One of the arguments that cynics of the NCLB Act have proposed was that there was too much focus on a narrow curriculum. NCLB's focus on just mathematic and reading scores could have a profoundly undemocratic effect upon a generation of students in poorly performing schools, as schools may strip away much of the broad education that has their birthright in order to elevate scores on just two indicators (McKenzie, 2003). Another argument of detractors that opposed this legislation was that there would be problems associated with having standardized tests to assess students. Critics had argued that the focus on standardized testing as the means of assessment encouraged teachers to teach narrow subsets of skills that would increase test performance rather than focus on deeper understanding that could readily be transferred to similar problems (International Reading Association, 2007).

Based on the historical actions of governmental agencies and organizations, literature that has been published, and legislation that has been passed, it was clear that it has been the goal of the United States government to establish a set of unified standards for the American education system. While the government had made significant efforts to establish an educational system that was based on standards, it has meet with varying levels of support and opposition. According to Stites (1999), standards have been one of the hottest topics in education reform for more than a decade. One of the most commonly heard arguments against the development of national K-12 content standards was that such standards might create a "standardized" national curriculum that lacked the diversity and flexibility that many saw as among the main strengths of the decentralized American educational system (Apple, 1993). Proponents countered by pointing out that content standards were meant to serve as general guides for curriculum and should ideally be "general, visionary, and not at all prescriptive" (Porter, 1993). Another objection to standards and subsequent assesments was that because each state could produce its own standardized tests, a state could make its statewide tests easier to increase scores (South Carolina Department of Education, 2003). A 2007 study by the U.S. Department of Education indicated that the observed differences in states' reported scores was largely due to differences in the stringency of their standards (National Center for Education Statistics, 2007). Nonetheless, despite setbacks at the national level, the standards movement marched on and seemed to be gaining ground at the state and local levels.

The STEM Initiative

While the standards movement seemed to be an ongoing trend that was directly related to general education reform, one exciting trend in technology education that was taking place was the integration of various subject areas with technology education. The combining of science, technology, engineering, and mathematics (STEM) to make an innovative new curriculum was quickly becoming the trend of many educational institutions that teach technology education. The STEM Education Coalition was a governmental agency that worked aggressively to raise awareness in Congress, the Administration, and other organizations about the role that STEM education plays in enabling the U.S. to remain the economic and technological leader of the global marketplace of the 21st century. Technology has played a strong role in state and local efforts to improve student achievement in recent years, as education officials have looked to gather data to improve instruction and use technology for purposes such as teacher professional development and online courses for students (Cavanagh, 2008). State and local school districts have also tried to boost students' overall technological literacy by implementing STEM related projects. It was the hope of policy makers, school systems, administrators, and educators that STEM was the type of subject integration that would foster greater student productivity, higher standardized test scores, and greater proficiency at mastering the necessary technological proficiencies to be productive in today's society.

It has been found that students do not possess sufficient mathematics and science skills when they graduate from high school. Almost 30 percent of high school graduates enter college unprepared for first year coursework, or arrive at the workplace without the mathematical, scientific, and technical skills that employers require (Carnegie Commission on Science, Technology, and Government, 1991). Although most states have a given set of standards that their students must cover in core academic areas such as mathematics and science, there were numerous inconsistencies from state to state as to which standards were emphasized. STEM content standards and the sequence in which content was taught varied greatly among school systems, as did the expectations for and indicators of success (National Science Board, 2007). States have no consensus on what key concepts students should master and what should be included in the curriculum at a certain grade level within specific content areas, so textbooks often cover too many topics at too superficial a level, rather than focus on a few key topics in depth (American Association for the Advancement of Science, 2005). The need to implement consistency with curriculum integration in school systems was becoming a crucial proposition. Many high schools provided a curriculum that was uninspiring, poorly aligned, outdated, lacking in rigor, and fraught with low expectations (National Science Board, 2007). If this was the trend in American public schools, possessing a high school diploma may not signify that a graduate would be able to succeed in a technologically advanced society.

Organizations Supporting STEM

The engineering community had identified the need for teaching engineering in K-12 classrooms. The American Society of Engineering Education (ASEE) had supported this perspective. Enhanced engineering education in our K-12 classrooms can provide more students a more specific understanding at an earlier age of what a technical career entails (Douglas, Iversen, & Kalyandurg, 2004). To address this need the National Center for Engineering and Technology Education (NCETE) was partnering with high school technology educators in summer inservice and workshops to help teachers develop activities and curricula to instill engineering design into technology education programs (Kelley, 2008). Since the publication of *Standards for Technological Literacy* in 2000 (ITEA), there have been a number of new programs developed that were designed to teach pre-engineering (Kelley, 2008). Endeavors were being made to bring engineering design and technology education programs together.

One way that these endeavors were being fulfilled was when the International Technology Education Association's Center to Advance the Teaching of Technology and Science (ITEA-CATTS) developed the only standards-based national model for grades K-12 that delivers technological literacy (ITEA, 2002). The model is called Engineering by Design, and it was built on *Standards for Technological Literacy* (ITEA), *Principles and Standards for School Mathematics* (NCTM) (2004), and *Project 2061 Benchmarks for Science Literacy* (AAAS) (2005). According to the ITEA (2002), students participating in the program learn concepts and principles in an authentic, problem-based environment. Some of the goals of the program were to ensure that all students were technologically literate, restore America's status as the leader in innovation, and increase student achievement in mathematics, science, and technology. The Engineering by Design curriculum is an excellent example of materials that had been developed to foster the growth of STEM based education in America.

Currently, many of the Nation's governors were leading new state initiatives to address STEM education needs, and the Federal agencies were beginning to take stock of existing diverse and dissimilar Federal STEM education programs (National Science Board, 2007). One program that supported some of these initiatives was at the forefront of changing the structure of school curricula and promoting the implementation of STEM ideologies was Project Lead the Way (PLTW). Project Lead the Way was a national 501 c3, not-for-profit educational program that helped give middle and high school students the rigorous ground-level education they needed to develop strong backgrounds in science and engineering (PLTW, 2008). Their mission was to create dynamic partnerships with the nation's schools to prepare an increasing and more diverse group of students to be more successful in science, engineering, and engineering technology. This organization had designed a middle and high school program where school systems could immediately implement pre-existing curricula for their students. The middle school program was called "Gateway to Technology" and its contained courses that covered subjects such as design and modeling, robotics, and aerospace engineering. The high school program was called "Pathway to Engineering" and offered courses that entailed the principles of engineering, engineering design, integrated manufacturing, architecture, and biomedical engineering. With all of this new material and curricula being offered to students, some may wonder if it was really being effective. According to current data, 73 percent of students who took three or more high school PLTW courses entered college or technical programs. Of these students, 85 percent continued in school and earned their degrees (Ryan, 2007). Because of the successes that PLTW had been showing in the academic performance of the students who were taking the courses, the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine (2004), concluded that PLTW should serve as a model for pre-engineering educational programs.

Another organization that was working to provide programs that support the philosophy of integrating mathematics, science, and technology was the Center for Occupational Research and Development (CORD). CORD had done research work in the development of curriculum integration frameworks based on academic, occupational, and employability standards. Some of their signature projects included the development of the Curriculum Integrator system and the academy for Information Technology. One of the projects that CORD had developed that strongly reflected the ideals of the STEM educational reform movement was their Math Enrichment for Career and Technical Education (CTE). This program encouraged a strong working relationship between mathematics teachers and the CTE teachers in each school. The CTE and mathematics teachers correlated CTE and mathematics standards and learned the process of developing workplace problems into CTE and mathematic courses (CORD, 2008). Because of organizations like CORD, the STEM initiative had another advocate for promoting curriculum integration and technological literacy for all people.

The Context of Technology Education

Technology education is vastly different in nature than technical education. Technical education deals with specific skills and technical proficiencies, whereas technology education deals with a global knowledge of technology and its role in society. Offering technology education courses to promote technological literacy and offering technical education can be a confusing comparison. The "T" in STEM initiatives has much more to do with technological literacy rather than schools providing technical education programs. To be technologically literate a person must have an understanding of the nature and history of technology, a basic hands-on capability related to technology, and the ability to think critically about technological development (National Academy of Engineering, 2002). Technological literacy was not the same as technical competence. Some individuals (e.g., plumbers, automobile mechanics, computer programmers, airplane pilots) may be very competent in the use of one or more specific technologies but may not be technologically literate (Ollis & Pearson, 2006). Although technological literacy included an element of hands-on ability, this does not necessarily imply a high level of practical or technical skill. Aside from technological literacy the "T" in STEM can also mean instructional technology. The International Society for Technology in Education (ISTE) was a non-profit organization that provided leadership and service to improve teaching, learning, and school leadership by advancing the effective use of technology in PK-12 and teacher education. To truly understand the focus of the STEM initiative and what it meant to be technologically literate, it was important for people to understand the major differences between technology education and career and technical education.

In order to further justify the need to have students take technology education courses as a part of their educational coursework, it would be very useful to show that technology education was contributing to improved academic performance. The emphasis on improving student achievement in the core academic areas has led technology educators to show linkages between their courses and the core academic areas (Dyer, Reed, & Berry, 2006). The role of technology education courses in many schools systems was to provide practical application to the concepts students learn in the core subjects. Technology education provided a contextual basis for reinforcing the content of the core areas (Berry & Ritz, 2004). The idea of putting a student's new knowledge into a context in which they could relate it had been a concept that has been put to use for many years in the field of technology education.

Transfer of learning was the application of skills and knowledge learned in one context being applied to another context (Cormier & Hagman, 1987). If the skills to be transferred can be identified and the context can be established where learners see that the skills they had learned could be applied to solve problems in other contexts (situations), then student success should improve (Bjork & Richardson-Klayhen, 1989). The goal of the STEM initiative was to integrate science, technology, engineering, and mathematics into a curriculum that helps students to become higher academic achievers and more technologically literate. By a technology education program being structured in a sequential and logical manner, students would likely become more technologically literate and show improvement in their core academic areas. Thoughtfully sequenced classes could be structured to balance students' acquisition of content knowledge with their development of analytical, critical thinking, and problem solving skills. They also would foster in students the ability to make connections among ideas and build a capacity for life-long learning (National Science Board, 2007).

Summary

Chapter II covered topics dealing with the history of technology education. Significant legislation leading to the development of technology education was also discussed in this chapter. Data were provided that explained the start of the standards movement in the American educational system, along with current legislation that was being implemented to promote proper use of a standards based curriculum. This chapter also expressed the importance of No Child Left Behind and STEM legislation that supported the academic integration of various curricula in the public school system. A summary of the initiatives that organizations such as the International Technology Education Association and its Engineering by Design curriculum, Project Lead the Way, and the Center for Occupational Research and Development were listed as advocates of STEM. The final portion of this chapter presented data that was supportive of the notion that technology education can contribute to the increase in student academic performance. The basis of this study is to see if the teaching of technology education led to improved learning in science, social studies, mathematics, and English/language arts. Chapter III will provide a profile of the population of students that were used in this study and the procedures of gathering research data.

Chapter III

Methods and Procedures

The methods and procedures that were used in this study are described in this chapter. This chapter will discuss the population chosen for this study, research variables, instrument design, the methods of data collection, and the statistical analysis. This study is quasi-experimental in nature.

Population

The population of this study consisted of 50 technology education program completers and an equal random sample of non-completers who graduated from an urban high school in Chesapeake, Virginia. The population was composed of 12th grade students during the 2007-2008 school year. The population of technology education program completers was the total number of graduates in 2008 that qualified to be classified as technology education program completers. The students who were classified as program completers finished at least two courses of a set of sequential technology education courses. One example of a set of sequential courses was the Production Technology Program Cluster. In order for a student to be classified a program completer of this cluster they would have to take two of the four courses offered, which are Production Systems, Materials and Processing, Construction, and Manufacturing. Table 1 is a list of all of the Virginia technology education program completer options and the requirements that a student must meet in order to be classified as a completer upon graduation.

Table 1.

Virginia completer options for technology education

Program Concentration Areas and Courses	Minimum Requirements for Program Completion
1. Communication and Information Technology Communication Systems Computer Control and Automation Graphic Communications	Communication Systems followed by Computer Control and Automation or Graphic Communications
2. Control Technology Electronics Technology I Electronics Technology II Power and Transportation Energy and Power	Electronics I followed by Electronics II or Power and Transportation followed by Energy and Power
3. Design and Technology Technology Foundations Technology Transfer Technology Assessment	Technology Foundations followed by Technology Transfer or Technology Assessment
4. Production Technology Production Systems Materials and Processing Construction Manufacturing	Materials and Processes or Production Systems followed by Construction or Manufacturing

Table 1. (Continued).

Program Concentration Areas and Courses	Minimum Requirements for Program Completion
5. Technical Design and Illustration	Technical Design followed by Engineering Design or Architectural Design
Technical Design	
Engineering Design	
Architectural Design	
6. Pre-Engineering	Both courses are required for completion
Introduction to Engineering	
Advanced Engineering	
7. Principles of Technology	Both courses are required for completion
Principles of Technology I	
Principles of Technology II	

The non-completers were students that graduated in 2008 that did not take any technology education courses to fulfill their elective requirements while they were in high school. This sample of students was chosen randomly from the high school's graduating class and was composed of 50 students. The school employed six technology education teachers during the 2007-2008 school year.

Research Variables

The independent variables for this study were students who were technology education completers and students that were not technology education completers. The dependent variables were the Standards of Learning (SOL) scores in the areas of mathematics, social studies, English/language arts, and science. Students who graduated from Virginia schools were required to complete standards tests after the ninth grade in Earth Science, World History I, and Algebra I. When the students complete the tenth grade they are required to complete standards tests for the subjects of Biology, World History II, and Geometry. When students complete the eleventh and twelfth grades they are required to complete standards tests for the subjects of United States History, Algebra II, and English Reading and Writing.

Instrument Design

In order to analyze the performance of the technology education program completers on their academic standards assessment tests, as opposed to the performance of students who did not take a technology education course, the researcher compared the Standards of Learning (SOL) scores related to mathematics, social studies, English/language arts, and science. In each category the researcher recorded the test score that correlated with the highest academic level that each student obtained in that subject (note: The score that the researcher recorded in the mathematics category for one student may be an algebra II score, whereas the score for another student might be a geometry score. The same practice applied to the other academic categories as well). No matter what level the student achieved in each category, the researcher always recorded the highest-level test score and listed them in the same general category.

The Virginia standards of learning exams were implemented as an assessment instrument in 1998. Virginia educators worked with the Department of Education and the Harcourt Brace Educational Measurement testing contractors to ensure that every item that appears on the Virginia SOL tests matched the state standards and test specifications

(Virginia Department of Education, 1999). The validity and reliability statistics from the first administration of the SOL tests were reviewed by outside testing experts who found the tests to have a solid structural foundation. They found that the Virginia SOL tests were comparable to other student performance assessment instruments such as the Stanford 9 and Literacy Passport (LPT) tests (Virginia Department of Education, 1999).

Methods of Data Collection

Pre-existing data were retrieved from the Chesapeake Public Schools database system. The researcher gained access to the database containing the standardized assessment records for each student in the population of this study. The data that were collected included the standardized assessment scores in the subjects of English/language arts, mathematics, science, and social studies. Protection of the human subjects in this study was upheld by keeping the identity of each participant confidential. The data were collected and input onto spreadsheets (see example in Table 2) where each student was assigned an identification number to eliminate the use of names and identifiable information of the participants. When reporting results in the study the researcher aggregated data from the spreadsheets and eliminated the code numbers to protect the confidentiality of each participant. The population of technology education completers in this study was compared to a random sampling of an equal number of students that have not taken any technology education courses.

Table 2.

Sample Data Collection Spreadsheet for Program Completers

Student Number	Language Arts SOL Score	Mathematics SOL Score	Science SOL Score	Social Studies SOL Score
0001	350	280	410	475
0002	289	360	500	390

Statistical Analysis

Multiple *t*-tests were calculated for each research objective to determine if they were significant between the SOL examination scores of technology completers as opposed to the scores of non-completers. The SOL scores of the non-completers were used to determine if there was a significant difference in the scores between the two groups. The *t*-test assessed whether the means of two groups were statistically different. A *t*-test analysis is appropriate whenever you want to compare the means of two groups. All of the *t*-tests in this study were employed to assess whether the means of assessment test scores of the completers were statistically different from the means of the assessment test scores of the non-completers.

Summary

Chapter III outlined the methods and procedures used to complete this study. Characteristics of the population for this study were clarified and explained. This chapter elaborated upon the instrument design and how the data were categorized and compared. The methods of data collection were described by explaining how the data were retrieved and from where the data came. The methods of data collection also explained how the data were recorded and aggregated. This chapter also gave details as to the statistical analysis used for this study and defined the two groups that were being compared. Chapter III allowed the researcher to collect data that will be presented as findings in Chapter IV.

Chapter IV

Findings

The problem of this study was to determine if technology education program completers score higher on academic standards assessments than do students who do not enroll in technology education courses. This chapter contains the data that were collected to satisfy the four aspects of this study. The data were used to determine if there were significant differences between state standardized assessment scores in mathematics, social studies, English/language arts, and science of technology education completers and students who did not take any technology education courses during high school.

Program Completers

The program completers for this study were selected by taking the necessary sequential technology education courses as mandated by Virginia state requirements for high school students. The academic transcripts for the 2008 high school graduates were analyzed and the population of program completers was determined based on the sequence of their technology education courses. The number of technology education program completers was 50. The population of non-completers was determined by only including students who were not members of the school band ensemble and those students who did not have any technology education courses while in high school. This random sample selected for non-technology education program completers was 50.

The demographics of the students in this study were reflective in regards to Asian and Hispanic students compared to the overall population of students in the Chesapeake Public School System. The categories of black and white students were significantly different when comparing the students in this study to the overall population of students in the Chesapeake Public School System. Table 3 shows a summary of the demographics for the school used in this study and the overall demographics for the Chesapeake Public School System in 2008. The information used in this table was gathered from the Chesapeake Public School System Database (School Matters, 2008)

Table 3.

Student demographics for sample population and Chesapeake public school system

Student Ethnic Background	Demographic Percentage for Sample Population	Demographic Percentage for Entire School System Population
Asian/Pacific Islander	2.8	2.9
Black	57.7	33.8
Hispanic	2.3	2.4
White	35.7	62.5
Other	1.2	1.2

Mathematics

The first research hypothesis stated that the students who are technology education program completers perform better on their mathematics standards tests (SOL) than students who are not enrolled in technology education courses. Table 4 lists the scores of the technology education program completers and the non-completers. The findings of this hypothesis showed that the mean score for program completers on their mathematics SOL tests was 466.9 and the mean score for non-completers was 441.7. The n for completers was 50 and the n for non-completers was 50. The degree of freedom was 98. The value of t was determined to be 3.07. This value exceeded the level of significance at the .01 level of significance where $p<.01=2.40$.

Table 4.

Mathematics SOL scores for completers and non-completers

Student Number	Technology Education Program Completers	Non-Completers
001	453	446
002	511	447
003	457	421
004	496	426
005	600	468
006	552	391
007	433	402
008	528	508
009	416	440
010	420	487
011	477	529
012	477	464
013	489	465
014	487	428
015	465	407
016	559	428
017	407	375
018	436	479
019	428	374
020	421	412
021	421	511
022	417	443
023	421	446
024	460	434
025	448	391
026	529	460
027	436	477
028	423	414
029	550	533
030	498	448
031	582	420
032	389	440
033	433	372
034	426	427

Table 4. (Continued).

Student Number	Technology Education Program Completers	Non-Completers
035	415	428
036	422	407
037	529	534
038	374	462
039	433	434
040	415	411
041	436	480
042	559	489
043	567	529
044	489	380
045	441	446
046	529	440
047	391	411
048	461	423
049	477	405
050	460	402
Mean Score	466.9	441.7

Social Studies

The second research hypothesis stated that the students who are technology education program completers perform better on their social studies standards tests (SOL) than students who are not enrolled in technology education courses. Table 5 lists the scores of the technology education program completers and the non-completers. The findings of this hypothesis showed that the mean score for program completers on their social studies SOL tests was 502.0 and the mean score for non-completers was 463.8. The *n* for completers was 50 and the *n* for non-completers was 50. The degree of freedom was 98. The value of *t* was determined to be 3.36. This value exceeded the level of significance at the .01 level of significance where $p<.01=2.40$.

Table 5.

Social studies SOL scores for completers and non-completers

Student Number	Technology Education Program Completers	Non-Completers
001	427	439
002	518	400
003	477	369
004	510	503
005	600	472
006	551	346
007	462	444
008	546	409
009	405	477
010	484	527
011	514	600
012	502	400
013	600	510
014	575	434
015	457	433
016	510	589
017	469	417
018	412	589
019	483	385
020	472	450
021	444	503
022	472	546
023	431	479
024	589	439
025	517	463
026	527	477
027	495	472
028	489	452
029	575	510
030	525	432
031	589	518
032	484	452
033	444	455
034	495	423
035	510	484
036	502	462
037	489	480
038	474	427

Table 5. (Continued).

Student Number	Technology Education Program Completers	Non-Completers
039	551	419
040	415	455
041	404	456
042	527	597
043	496	495
044	572	408
045	472	452
046	538	600
047	589	424
048	535	392
049	495	379
050	527	448
Mean Score	502.0	463.8

English/Language Arts

The third research hypothesis stated that the students who are technology education program completers perform better on their English/language arts standards tests (SOL) than students who are not enrolled in technology education courses. Table 6 lists the scores of the technology education program completers and the non-completers. The findings of this hypothesis showed that the mean score for program completers on their English/language arts SOL tests was 474.7 and the mean score for non-completers was 464.6. The *n* for completers was 50 and the *n* for non-completers was 50. The degree of freedom was 98. The value of *t* was determined to be 1.14. This value did not exceed the level of significance at the .05 level of significance where $p<.05=1.67$.

Table 6.

English/language arts SOL scores for completers and non-completers

Student	Technology Education	
Number	Program Completers	Non-Completers
001	424	414
002	556	483
003	453	416
004	565	488
005	515	454
006	482	384
007	457	476
008	492	440
009	415	479
010	446	451
011	414	535
012	466	436
013	505	454
014	532	410
015	447	514
016	591	505
017	460	422
018	380	498
019	442	438
020	477	500
021	442	508
022	488	494
023	426	442
024	443	466
025	449	430
026	557	591
027	431	523
028	435	512
029	488	431
030	507	445
031	521	546
032	446	484
033	412	449
034	488	414
035	488	462
036	438	439
037	476	469
038	442	409

Table 6. (continued).

Student Number	Technology Education Program Completers	Non-Completers
039	510	455
040	434	427
041	437	497
042	526	488
043	535	512
044	551	413
045	436	466
046	468	599
047	486	432
048	507	414
049	475	417
050	474	399
Mean Score	474.7	464.6

Science

The fourth research objective stated that the students who are technology education program completers perform better on their science standards tests (SOL) than students who are not enrolled in technology education courses. Table 7 lists the scores of the technology education program completers and the non-completers. The findings of this hypothesis showed that the mean score for program completers on their science SOL tests was 459.7 and the mean score for non-completers was 430.8. The *n* for completers was 50 and the *n* for non-completers was 50. The degree of freedom was 98. The value of *t* was determined to be 3.24. This value exceeded the level of significance at the .01 level of significance where $p<.01=2.40$.

Table 7.

Science SOL scores for completers and non-completers

Student Number	Technology Education Program Completers	Non-Completers
001	413	362
002	513	471
003	450	390
004	413	475
005	532	450
006	483	441
007	425	376
008	526	414
009	414	425
010	409	502
011	445	449
012	488	423
013	528	434
014	513	429
015	444	425
016	600	440
017	421	407
018	438	460
019	435	458
020	484	488
021	471	404
022	446	468
023	395	400
024	456	421
025	452	412
026	548	434
027	400	433
028	426	454
029	579	409
030	475	415
031	453	417
032	446	423
033	429	425
034	417	400
035	418	418
036	416	423
037	475	427
038	425	439

Table 7. (Continued).

Student Number	Technology Education Program Completers	Non-Completers
039	479	430
040	409	430
041	397	488
042	548	438
043	474	468
044	581	368
045	421	421
046	483	575
047	379	406
048	425	400
049	425	386
050	452	391
Mean Score	459.7	430.8

Summary

Chapter IV provided results of the data collected from the student SOL assessment tests in the subject areas of English/language arts, mathematics, science, and social studies. The students who were technology education program completers were compared to students whom were not enrolled in technology education courses. Multiple *t*-tests were used to determine the level of significance between the completers and non-completers in each subject area. Table 8 shows a summary of the mean scores and *t* values for each pair of sample groups that were compared in this study. Chapter V will provide the Summary, Conclusions and Recommendations of this study.

Table 8.

Aggregate data for program completers and non-completers

Paired Samples	Subjects	Standard Deviation	Mean Scores	*t* values	Levels of Significance .01	.05
1	Math Completers	57.88	466.9	3.07	2.40	1.67
	Math Non-Completers		441.7			
2	English Completers	62.95	474.7	1.14	2.40	1.67
	English Non-Completers		464.6			
3	Science Completers	62.93	459.7	3.24	2.40	1.67
	Science Non-Completers		430.8			
4	Soc. Studies Completers	80.36	502.0	3.36	2.40	1.67
	Soc. Studies Non-Completers		463.8			

Chapter V

Summary, Conclusions, and Recommendations

The purpose of this chapter was to report the summary, conclusions, and recommendations of this study. The information in this study was based on the results of the research data that were obtained from the transcripts of the 2007-2008 high school graduating class of one high school in southeastern Virginia. There were a total of 100 students who were included in this study. Half of the students were technology education program completers and the other half was a random sampling of students who did not take technology education courses.

Summary

The problem of this study was to determine if technology education program completers score higher on academic standards assessments than do students who do not enroll in technology education courses. There were several hypotheses that were used in order to find an answer to this problem. The first hypothesis was to determine if students who were technology education program completers performed better on their mathematics standards tests (SOL) than students who were not enrolled in technology education courses. The second hypothesis was to determine if students who were technology education program completers performed better on their social studies standards tests (SOL) than students who were not enrolled in technology education courses. The third hypothesis was to determine if students who were technology education program completers performed better on their English/language arts standards tests (SOL) than students who were not enrolled in technology education courses. The fourth hypothesis was to determine if students who were technology education program completers performed better on the science standards tests (SOL) than students who were not enrolled in technology education.

The significance of this study was to determine if technology education program completers were showing a better overall performance on their state standardized assessments than students who do not take technology education classes in high school. The nature of technology education courses is to encompass several of the core subject areas as a part of the overall curriculum by implementing practical activities and exercises. Technology education provided a contextual basis for reinforcing the content of the core areas (Berry & Ritz, 2004). Technology has played a strong role in state and local efforts to improve student achievement in recent years, as education officials have looked to gather data to improve instruction and use technology for purposes such as teacher professional development and online courses for students (Cavanagh, 2008).

By technology education courses being structured to support many of the core subject areas in high school, it is conceivable that students who take these courses in sequence may perform better on their standardized assessments than those students who do not have the experiences of these courses. If the skills to be transferred can be identified and the context can be established where learners see that the skills they had learned could be applied to solve problems in other contexts (situations), then student success should improve (Bjork & Richardson-Klavhen, 1989). The emphasis on improving student achievement in the core academic areas has led technology educators to show linkages between their courses and the core academic areas (Dyer, Reed, & Berry, 2006). The purpose of this study was to determine if there was a significant difference in the scores of program completers as compared to those of non-completers.

There were multiple limitations that were associated with this study. The first limitation was that the data collected were limited to graduating high school technology education program completers and a sample of non-completers from a high school in southeastern Virginia. The second limitation was that the data collected were limited to the Standards of Learning (SOL) examination scores of high school seniors in the core subject areas of mathematics, science, social studies, and English/language arts. The third limitation was that the data collected were limited to students who were not members of the high school band ensemble. This limitation was cited because research has shown that band students usually outperform other school populations when tested. According to Babo (2004), results from a study of middle school band students suggested that instrumental music participation does have a positive relationship to a student's academic performance with the strongest association occurring in reading and/or language arts. High school seniors who participated in instrumental music in grades 6-12 score significantly higher in language arts and mathematics on standardized tests than do students involved in non-music extra-curricular activities or with students not involved in any related extra-curricular activity (Trent, 1996). In a study conducted by Kluball (2000), there was a significant correlation between the number of years a student has band instruction and academic achievement. These students had a significantly higher level of performance on their Georgia High School standardized graduation tests in mathematics and science.

The population of this study was 100 of the 2008 graduates from an urban high school in southeastern Virginia. There were 50 students that were technology education program completers and 50 were students who were randomly selected and did not have technology education courses while attending high school. The demographics of the students in this study were reflective in regards to Asian and Hispanic students compared to the overall population of students in the Chesapeake Public School System. The categories of black and white students were significantly different when comparing the students in this study to the overall population of students in the Chesapeake Public School System. There were no instruments that were used in this study. All data were acquired from student records that were saved in the school's databases. All data were collected with permissions given by the school administration. Multiple *t*-tests were used to compare the significance of scores in mathematics, science, social studies, and English/language arts for completers and non-completers.

Conclusions

The first hypothesis stated H_1: Students who were technology education program completers performed better on their mathematics standards tests (SOL) than students who were not enrolled in technology education courses. The findings of this study showed that the mean score for technology education completers was 466.9. The mean score for non-completers was 441.7. The degree of freedom was 98. The value of *t* was determined to be 3.07. This value exceeded the .01 and level of significance where $p<.01=2.40$. Therefore, the researcher accepts the statement of high school technology education program completers performing better on their mathematics SOL assessment tests than students who did not take technology courses at the .01 level of significance.

These results are similar to the findings of another study that measured standardized test scores of mathematics students enrolled in a technology education courses as opposed to students who were not enrolled in technology courses. According to Dyer (2004), students who took the illustration and design technology education courses were more likely to pass their Algebra I and Geometry standards tests (SOL). In another related study it was found that high school students who completed pre-engineering technology education courses scored significantly higher on state mathematics tests than students who did not enroll in technology education courses (Settar, 2006).

The second research hypothesis stated H_2: Students who were technology education program completers performed better on their social studies standards tests (SOL) than students who were not enrolled in technology education courses. The findings of this study showed that the mean score for technology education completers was 502.0. The mean score for non-completers was 463.8. The degree of freedom was 98. The value of t was determined to be 3.36. This value exceeded the .01 level of significance where $p<.01=2.40$. Therefore, the researcher accepts the statement of high school technology education program completers performing better on their social studies SOL assessment tests than students who did not take technology courses at the .01 level of significance. These findings are very indicative of the perspective of how students need to be aware of how technology affects our society. According to *Standards for Technological Literacy (STL)* (2002), students need to develop an understanding of the cultural, social, economic, and political effects of technology. The effects of society on technology and technology on society go hand in hand, so the two march together toward the future.

A study conducted by Culbertson, Daugherty, and Merril (2004) examined the potential achievement gains of middle school students who were taking a middle school modular technology education course. Even though no significant gains were found in the achievement level of the modular technology education students, it is worth noting that both seventh and eighth grade students made gains in their social studies achievement scores that exceeded those of the students who did not have the modular technology education course. The mean scores of the students that had a full treatment (12 weeks) of the modular technology education course were higher than those students that had half of a treatment (6 weeks). The mean scores of the students that had half of a treatment were higher than the students that did not have the modular technology education course.

The third research hypothesis stated H_3: Students who were technology education program completers performed better on their English/language arts standards tests (SOL) than students who were not enrolled in technology education courses. The findings of this study showed that the mean score for technology education completers was 474.7. The mean score for non-completers was 464.6. The degree of freedom was 98. The value of *t* was determined to be 1.14. This value did not exceeded the .05 level of significance where $p<.05=1.67$. Therefore, the researcher rejects the statement of high school technology education program completers performing better on their English/language arts SOL assessment tests than students who did not take technology courses at the .05 level of significance. The results of the English/language arts portion of this study were very similar to a study conducted that examined the achievement scores of middle school language arts students. According to Bolt (2005), there was no significant difference in the English/language arts standards test (SOL) scores of eight grade technology education students as compared to students who did not have a technology education course.

The fourth research hypothesis H_4 stated: Students who were technology education program completers performed better on their science standards tests (SOL) than students who were not enrolled in technology education courses. The findings of this study showed that the mean score for technology education completers was 459.7. The mean score for non-completers was 430.8. The degree of freedom was 98. The value of *t* was determined to be 3.24. This value exceeded the .01 level of significance where $p<.01=2.40$. Therefore, the researcher accepts the statement of high school technology education program completers performing better on their science SOL assessment tests than students who did not take technology courses at the .01 level of significance. These results are somewhat similar to a portion of the results that were found in a study of middle school science students. According to Hammons (1999), the second semester technology education students had higher science grade point averages than the grade point averages of students who did not have technology education courses. There was no significant difference between these two means in his study, but the fact that the technology education students had higher grade point averages is notable.

Recommendations

Based upon the research findings and conclusions of this study, the researcher included several implementation recommendations. The first recommendation is that school guidance departments should be made aware of regulations that are mandated by the state which constitute a technology education program completer. Even if a state does not have program completer endorsements for their graduates, the school guidance counselors should be very familiar with the sequential technology education courses and make efforts to schedule students to receive those courses in the proper order. Because technology education courses are often considered elective courses for high school students, careful planning of these courses needs to be carefully coordinated between the guidance counselor and the student. The researcher also recommends that efforts should be made to schedule students to have sequential technology education courses as early in their high school years as possible. Technology education courses integrate content from many of the core academic subjects and implement it into practical applications. One of the programmatic goals of technology education is applying other school subjects (ITEA, 1985). If the skills to be transferred can be identified and the contexts can be established where learners see that the skills that they have learned can be applied to solve problems in other contexts (situations), then student success should improve (Bjork & Richardson-Klavhen, 1989). Because technology education courses are dedicated to this type of integration and based on the results of this study, it may be better for students to have sequential courses before they are to take their higher level state standardized tests.

A second implementation recommendation is for school systems to afford core subject teachers and technology education teachers more planning and curriculum articulation time or workshops to begin discussions and learn what the research has found. The emphasis on improving student achievement in the core academic areas has led technology educators to show linkages between their courses and the core academic areas (Dyer, Reed, & Berry, 2006). It is very difficult for technology education teachers and core subject teachers to be familiar with any similarities between content that they teach to their students. If these teachers could have the opportunity to collaborate, it may be possible to establish alignment between the subjects and provide the technology education teachers the opportunity to further reinforce the core subject areas. This type of collaboration could contribute to making the content more relevant to the students and promote further understanding. An organization that was working to help school systems, teachers, and administrators to identify similarities between various subject areas is the Mid-Continent Research for Educational Learning organization (MCREL). The goal of this organization was translating rigorous research into products and services to help improve student achievement. Data on students taking career and technical education (CTE) courses and performance in the four content areas indicate an increase in secondary students taking CTE courses and an increase in the pass rate percentage from the 2000-2001 academic school year to the 2002-2003 academic school year (Virginia Department of Education, 2000, 2001, 2002, & 2003).

A third implementation recommendation is to explore the possibilities of establishing sequential technology education courses for the elementary grades where the integration of content is promoted. Elementary students are responsible for completing standardized assessments in Virginia once they reach the third grade. It would be interesting to investigate the relationship of students taking sequential technology education courses and the significance of their performance on the state's standardized assessment tests. In September of 1990 technology education became a compulsory subject in the United Kingdom for all pupils age 5-16. Teachers of all subjects are required to include design and technology into their lessons where it is paired up with information technology to create the foundation subject area of technology education (Atkinson, 1990). If significance in student's performance on state standardized assessments could be found at the elementary level, it may provide further justification for school districts to implement elementary technology education programs as a part of their overall curriculum. James (2002) found a significant increase in the fifth grade student's Virginia SOL scores by teaching these students design and technology using project UPDATE (Upgrading Practice through Design and Technology "Engineering" Education) methods and materials. The improvements were evident in the subjects of English and science, and although mathematics was not statistically significant it is important to note that improvement was shown in 94% of the cases in this study.

A fourth implementation recommendation is that technology education high school teachers should be made aware that they need to include additional activities in their instructional strategies that apply English/language arts skills. The only subject in this study that did not show a significant difference in achievement was English/language arts. By implementing these strategies it would allow for the students to have more practice with reading comprehension and writing mechanics. Students have to utilize language and reading skills daily in order to understand and accomplish tasks for assessment, which in turn can strengthen their language and reading proficiency (Bolt, 2005). As a major human endeavor, our use of technology not only requires specific language, but also creates new understandings and knowledge, and for that reason technology should be an integral part of the schools' curriculum (Lewis & Zuga, 2005).

Based upon the research findings and conclusions of this study, the researcher included several recommendations for further study. One way that this study could be validated is to include a significantly larger population of students. Because this study was limited to a single school population, a study that included a student population of an entire school district or state would be significantly more robust. Massachusetts has direct standardized assessment of their technology education students on a large scale. The assessment of technology education students in Massachusetts began with the *Massachusetts Science and Technology/Engineering Curriculum Framework* (2001). This framework, for the first time, articulated standards for full-year high school courses in technology/engineering and identified a subset of core standards for each course that was designed to serve as the basis for the Massachusetts Comprehensive Assessment System (MCAS) (Massachusetts Board of Education, 2006). The MCAS test is a criterion-referenced test that covers the four major content areas of English/language arts, mathematics, science and technology/engineering, and history/social science (Massachusetts Board of Education 1998). Since Massachusetts has already implemented state technology standards, evaluating the performance of technology education students that take sequential technology courses as opposed to students who do not take sequential technology education courses would provide a researcher with a large population of students to analyze.

A second recommendation for further study would be for a researcher to perform a comparison study for students in a state other than Virginia. Each state has its own set of standards, technology education programs, and testing methods. It would be interesting to perform this study on a larger set of students in another state with a different set of standardized assessment tests. Massachusetts is one of only two states that have implemented its own set of state technology education standards (Rogers, 2006). It would be compelling to use their students to perform a similar comparative study to evaluate the performance of high school technology students on state standards tests as opposed to students who did not take technology education courses.

A third recommendation for further study is for a researcher to analyze the significance of students taking sequential technology education courses and their performance on every level of standardized assessment in each subject. If this kind of study were devoted to the subject of mathematics, the researcher would analyze the student's performance on every level of mathematics assessment (e.g., Algebra I, Geometry, Algebra II) instead of only recording the scores attained at the highest level. A study by Settar (2006) was conducted which analyzed technology education student performance on the Algebra II and Geometry standards test (SOL) in Virginia as opposed to students who were not enrolled in technology education. This type of study provided specific insight as to how technology education program completers are performing as opposed to students who do not take technology education courses at specific levels of their core subjects.

A fourth recommendation for a further study is for a researcher to conduct a study that relates to the ITEA/CATTS Engineering by Design curriculum. Students participating in the program learn concepts and principles in an authentic, problem based environment (ITEA, 2002). The focus of this study could be to see how the courses in this curriculum can contribute to improving the core subjects since their designs include mathematics and science standards. Establishing linkages between the Engineering by Design curriculum and the core subjects could lead to possible improvements in student academic achievement.

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Personal Information

Born: August 28, 1976 in Richmond, VA
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Education

B.S. Technology Education, 1998, North Carolina State University, Raleigh, NC
M.S. Occupational and Technical Studies, 2004, Old Dominion University, Norfolk, VA
Ph.D. Occupational and Technical Studies, 2009, Old Dominion University, Norfolk, VA

Honors and Awards

- Donald Maley Spirit of Excellence Outstanding Graduate Student Citation (Presented at the International Technology Education Association Conference 2004)

- Occupational and Technical Studies of Old Dominion University Doctoral Fellowship (Presented in the Fall 2008)

- The Donald Maley Foundation for Technology Education Teacher Scholarship (Presented at the International Technology Education Association Conference 2009)

- The Meredith Construction Company Scholarship (Presented in the Spring 2009)

Association Memberships

- International Technology Education Association
- Epsilon Pi Tau Honor Society
- Iota Lambda Sigma Honor Society
- Golden Key Society
- Twenty-First Century Leader Associates (Council on Technology Teacher Development Initiative)

Professional Experience

- High School Technology Education Teacher (1999 to Present)
  - Experience in the areas of Communication Technology, Manufacturing, and Technical Design

- Graduate Assistant (Summer 2006)

  Performed various duties such as departmental course scheduling and planning as well as organizing and processing resources for research.

Research Interests

I have interest in technological literacy and how it relates to standardized testing. I also have an interest in STEM education and how it can be developed and utilized by public school systems as a part of their curriculum.

Current Research

My current research deals with state standardized test scores of high school technology education program completers as opposed to students who are not technology education students. I am looking to see if there is a relationship between a student being a program completer and their performance on their state standardized assessment.

I am currently on the National Assessment of Educational Progress (NAEP) planning committee where we are charged with creating a new framework to assess technological literacy. This framework will be used as the basis to create testing instruments that will be used to assess technological literacy with 4th, 8th, and 12th grade students. The new instrument will be piloted for 8th graded students in 2012.

Professional Presentations

"The Value of Technology Education" given at the International Technology Education Association Annual Conference in Salt Lake City, Utah in March of 2008.

"The Value of Technology Education" given at the Southeastern Technology Conference in Norfolk, Virginia in October of 2008.

"Are technology education completers performing better?" given at the International Technology Education Association Annual Conference in Louisville, Kentucky in March of 2009.

Publications and Papers

Frazier, M. & Ritz, J. (2008). Monuments: Landmarks and Reflections from the Past.

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